

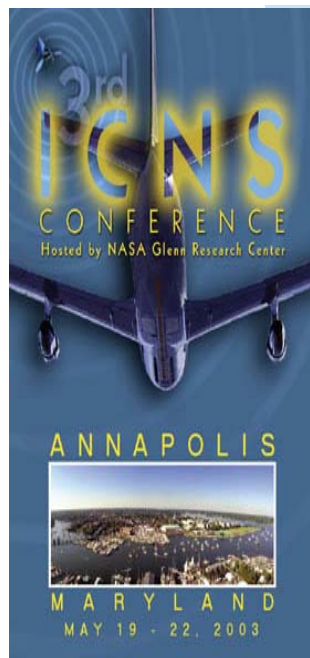


A Small Aircraft Transportation System...

Small Aircraft Transportation System



Can Be Networked...



***Peter McHugh
FAA SATS Program Manager
William J. Hughes Technical Center
@NASA Langley Research Center, Hampton, Virginia***



We'll Discuss...

Small Aircraft Transportation System

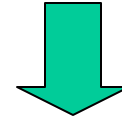


- *The National Transportation Crisis*
- *Vision - and its Role in Public Investment*
- *Introduction of Innovation into the Market*
- *SATS, Vision, Project and Why*
- *A Concept for 4 Operating Capabilities*
- *Aircraft (and Airports) Can Be Networked*
- *Collaboration (Public/Private Partnerships) Challenges
“Herding Cats”*

“Transportation is critical to the nation’s economy and our quality of life...but today we are straining its capacity limits, producing delays and congestion...”



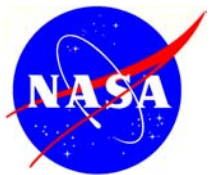
- Capacity
- Reduced travel times
- Efficiency
- Access and mobility



Should small aircraft/airports be among the options considered?

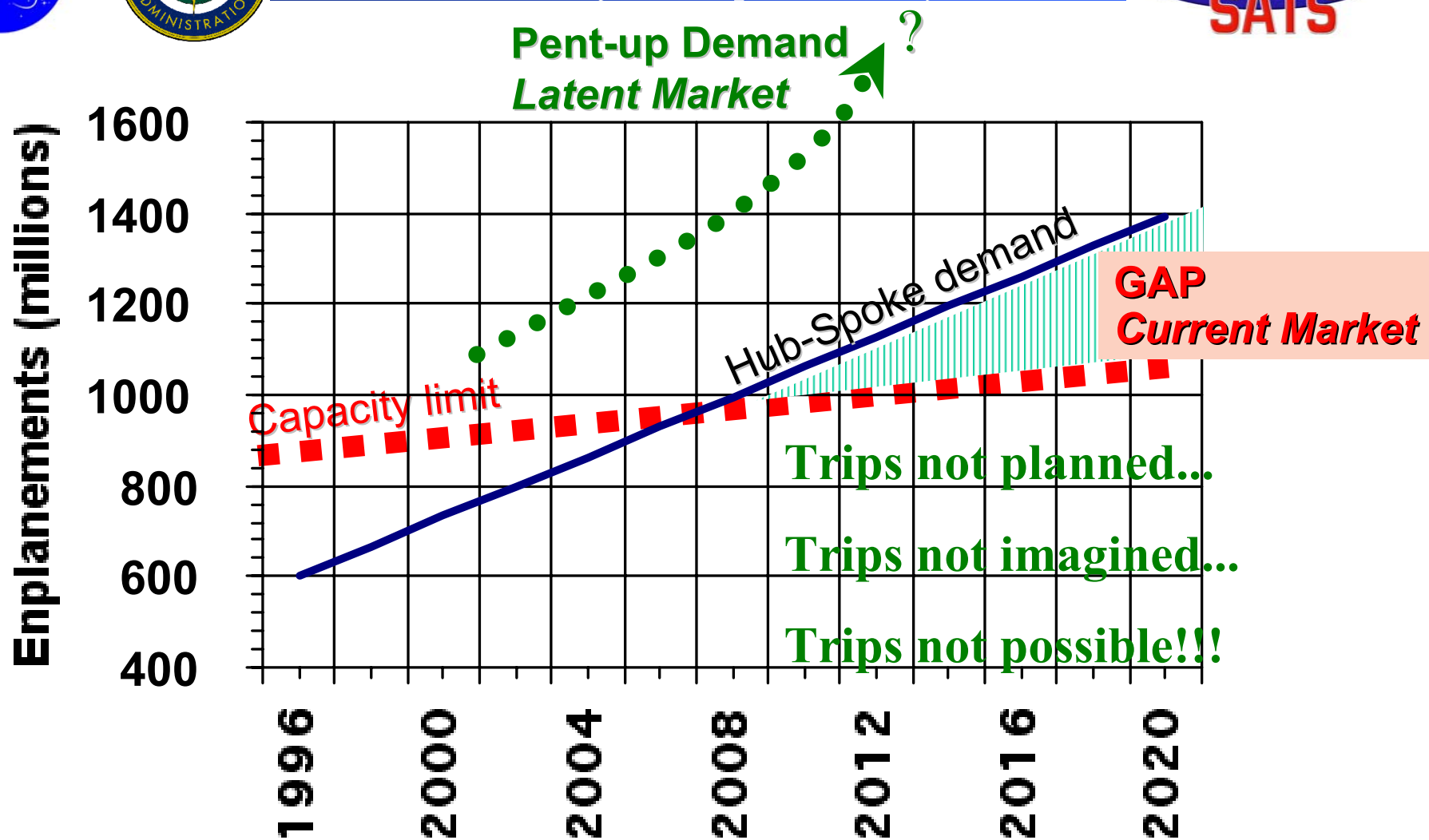


* Robert Spitzer, Chair (Federal Transportation Advisory Group)
“Vision 2050, An integrated National Transportation System”



Demand Will Soon Exceed Supply

Small Aircraft Transportation System

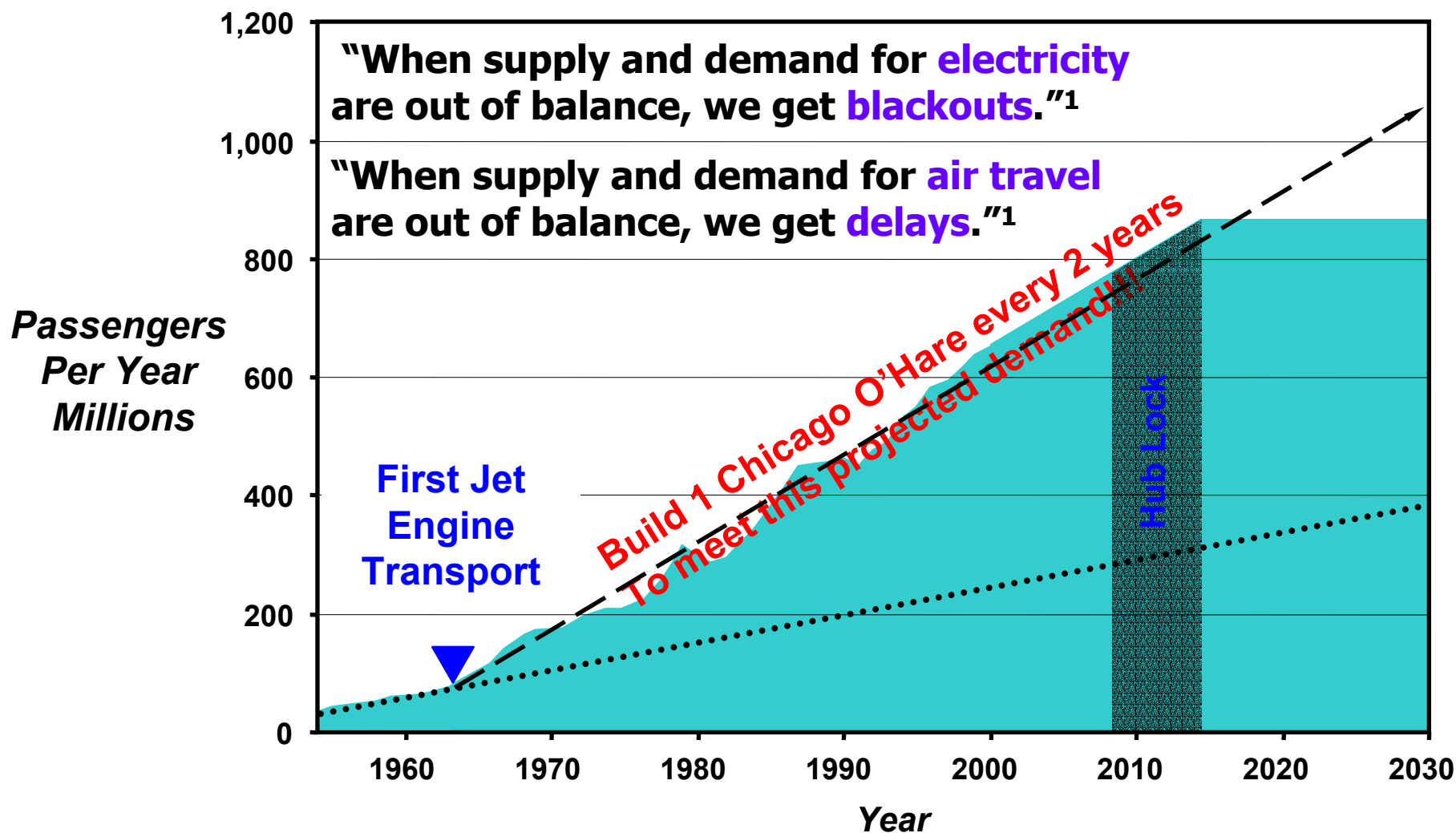


...not even considering pent-up travel demand...

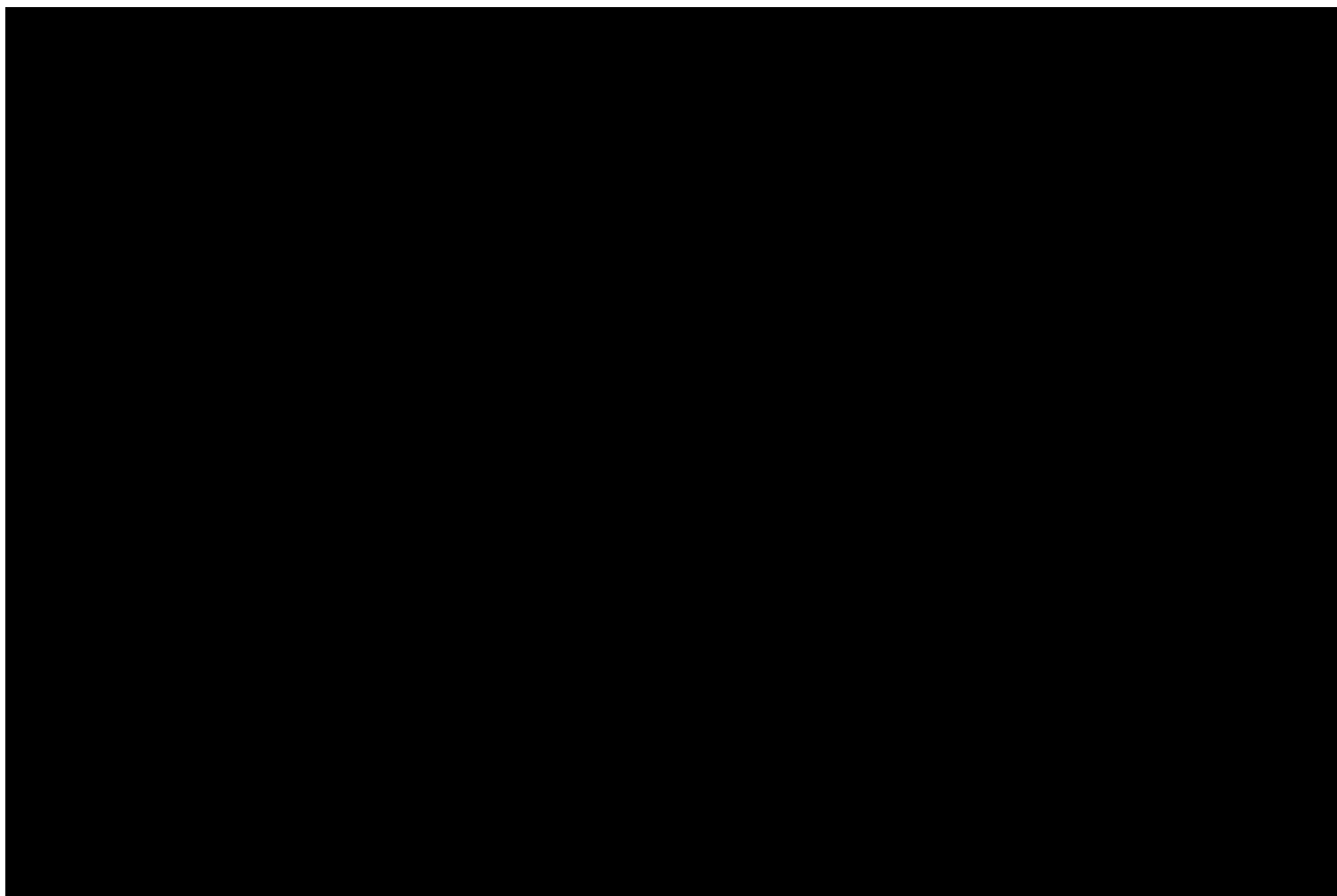


Hub Airports Nearing Capacity Limits

Small Aircraft Transportation System



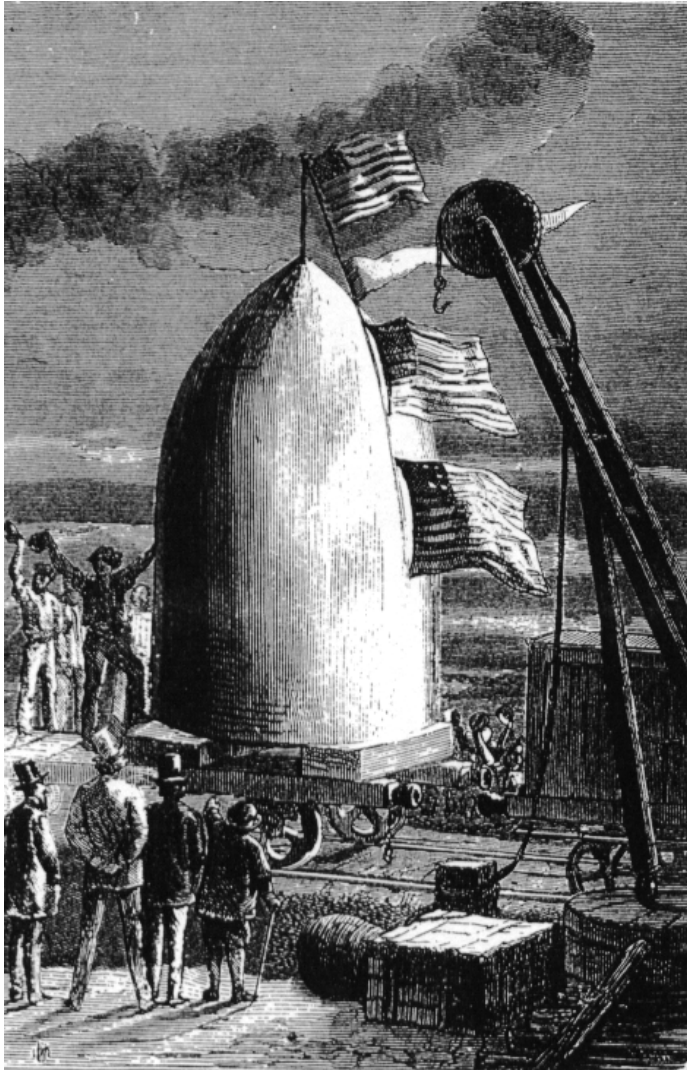
¹ Steve Morrison, Northeastern University economist
I-CNS Annapolis 21 May 03.ppt:



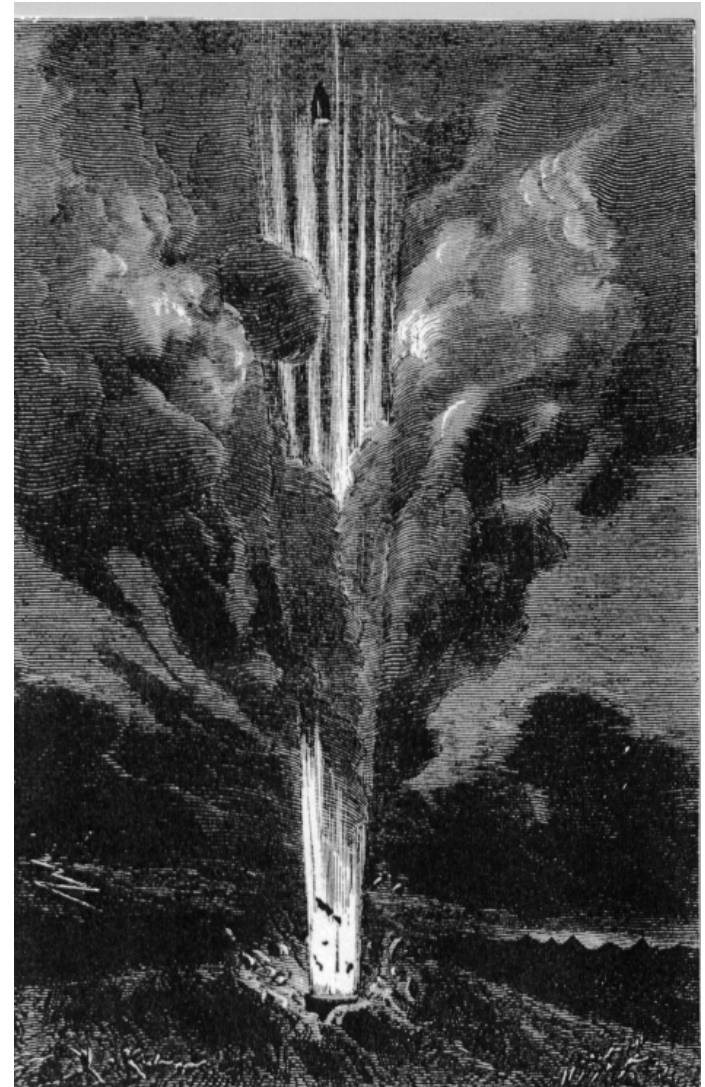
“It is the human nature to dream...”



Small Aircraft Transportation System



**V
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S
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O
N**



and to imagine not what is but what might be...”

“...in ten years, to put a man on the moon...”



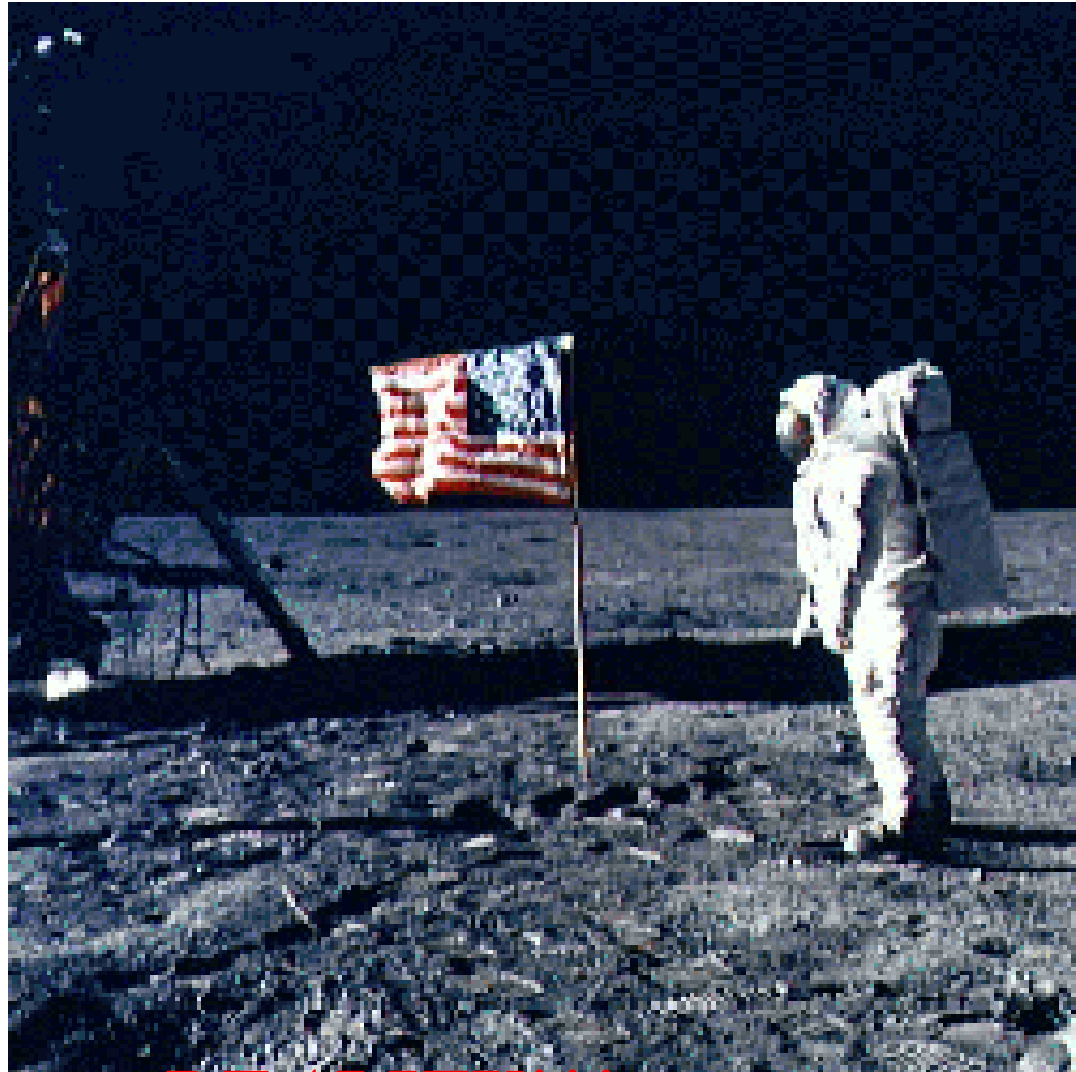
Small Aircraft Transportation System



Look what we did?

*Look where we've
come?**

* REDAC ATS SC
Participant, 4 Mar '03

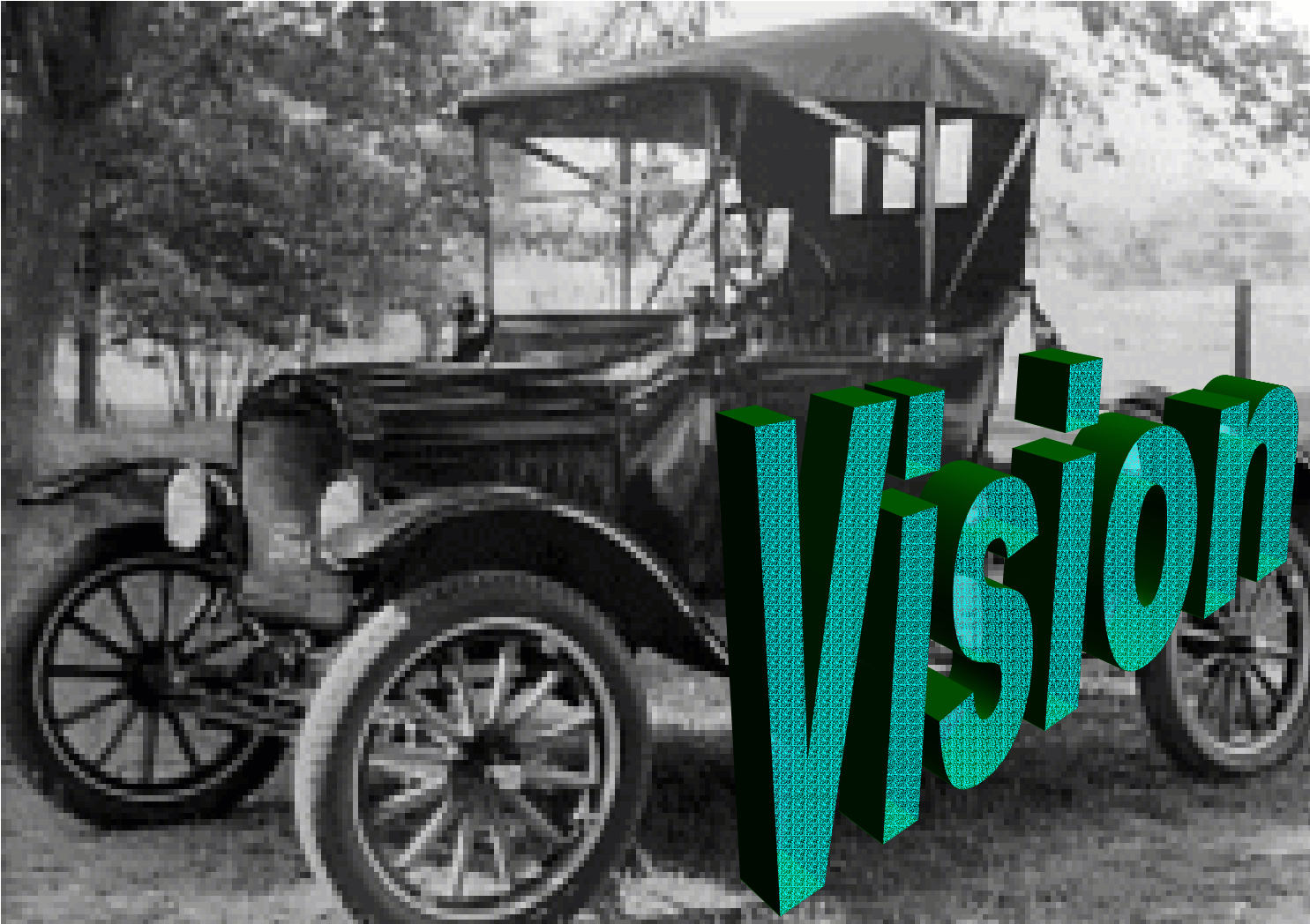


REALITY!!!

Why Would anyone want to build a path for that?



Small Aircraft Transportation System



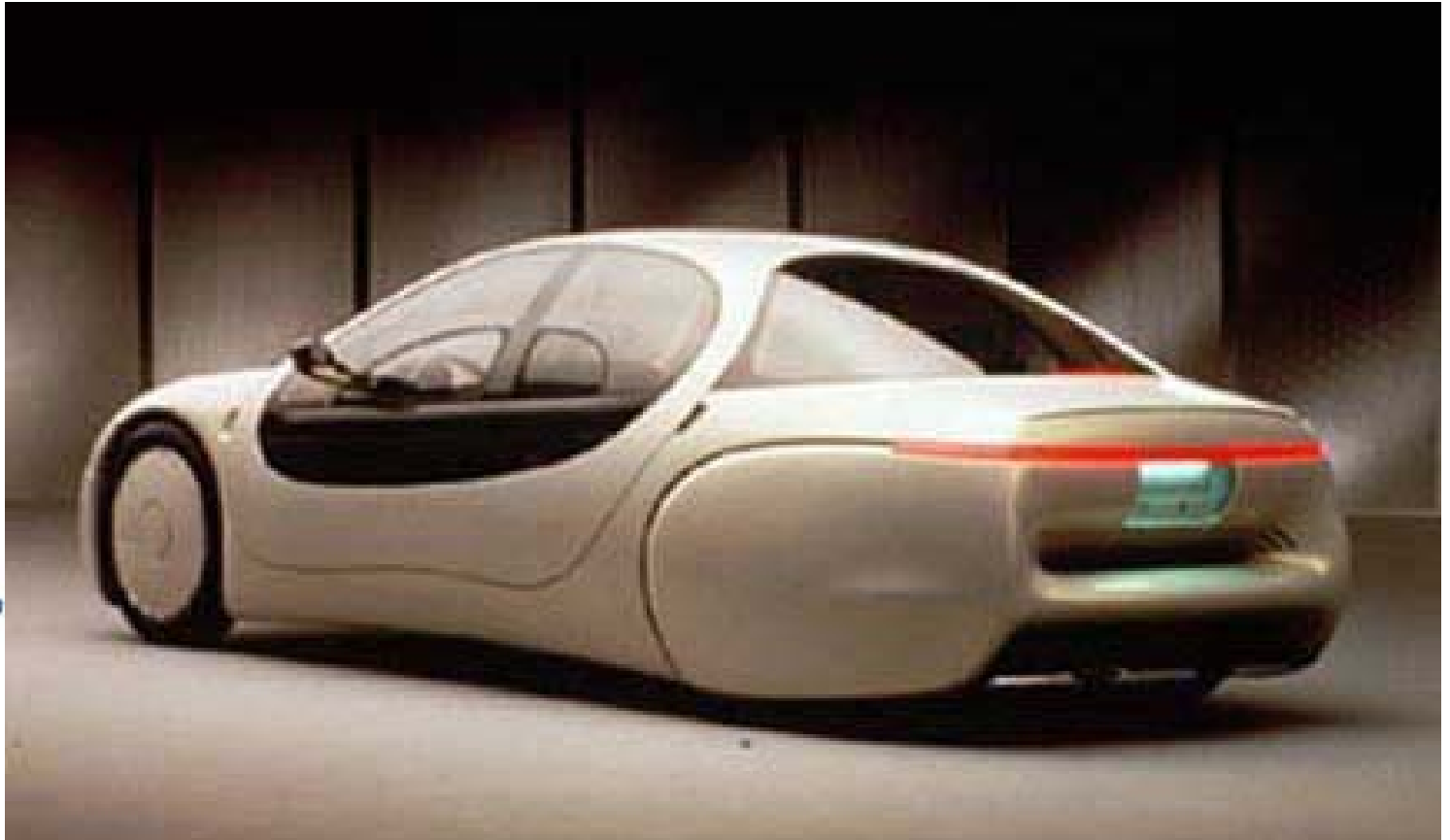


**The age of a
flying car in
every garage
may be dawning.**

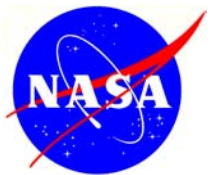
**"Mark my word:
A combination
airplane and motor
car is coming. You
may smile. But it
will come."
-- Henry Ford,**

1940

Imagine what the future could be...??



GM Composite Car built by Scaled Composites, 420 lb body

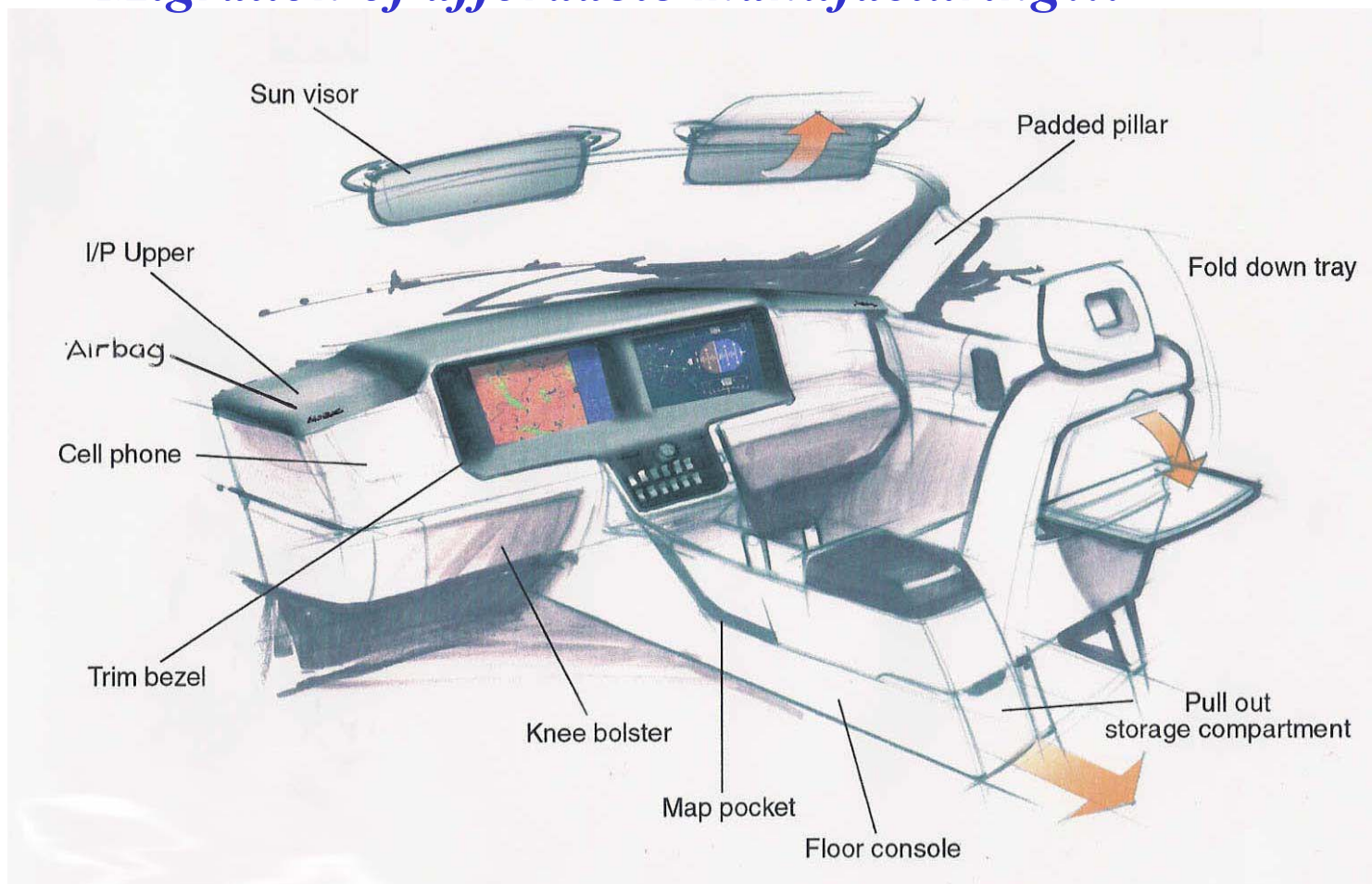


New Safety and Comfort!

Small Aircraft Transportation System



Migration of affordable manufacturing...



...from cars to planes.



New/Simplified Controls

Small Aircraft Transportation System



Imagine (*in your car*):

- Single control
- Intuitive
- Cruise control like
- All axis control





Migration of technologies

Small Aircraft Transportation System

Cockpit to auto to cockpit



Affordable “Heads-up Display and vision enhancements



Airborne Internet enabled....

Small Aircraft Transportation System



Communications to PDA-like devices for:



- Flight information
- Traffic Information
- Commercial Info

Tomorrow's transportation system...



Small Aircraft Transportation System



...must be “intermodal!”



Technical Context for SATS

Small Aircraft Transportation System



Moore's Law on microprocessor performance

Computing power will double each 18 months

Gilder's Law on bandwidth performance

Communication power will double each 6 months

Metcalf's Law on network performance

Value of network proportional to terminal squared

The unwritten law of abundance

We waste what we have in abundance

The unwritten rule of gridlock

Every added mile creates more demand

Kurzweil's Law of Accelerating Returns

More technology in next decade than past century

Golden Rule of the information age

Treat other people's time as ...



The Difficulty About Predictions...

Small Aircraft Transportation System



- “The telephone has too many shortcomings to be seriously considered as a means of communication.”**
– Western Union executive, 1876
- “The problem with television is that the people must sit and keep their eyes glued on a screen; the average American family hasn’t time for it.”**
– NY Times, 1939 (World’s Fair)
- “I think there is a world market for maybe five computers.”**
– IBM Chairman Thomas Watson, 1943
- “Computers in the future may weigh no more than 1.5 tons.”**
– Popular Mechanics, 1949
- “There is no reason for individuals to have a computer in their home.”**
– DEC Chairman Ken Olson (DEC), 1977
- “64,000 bytes of memory ought to be enough for anybody.”**
– Microsoft Chief Software Architect Bill Gates, 1981



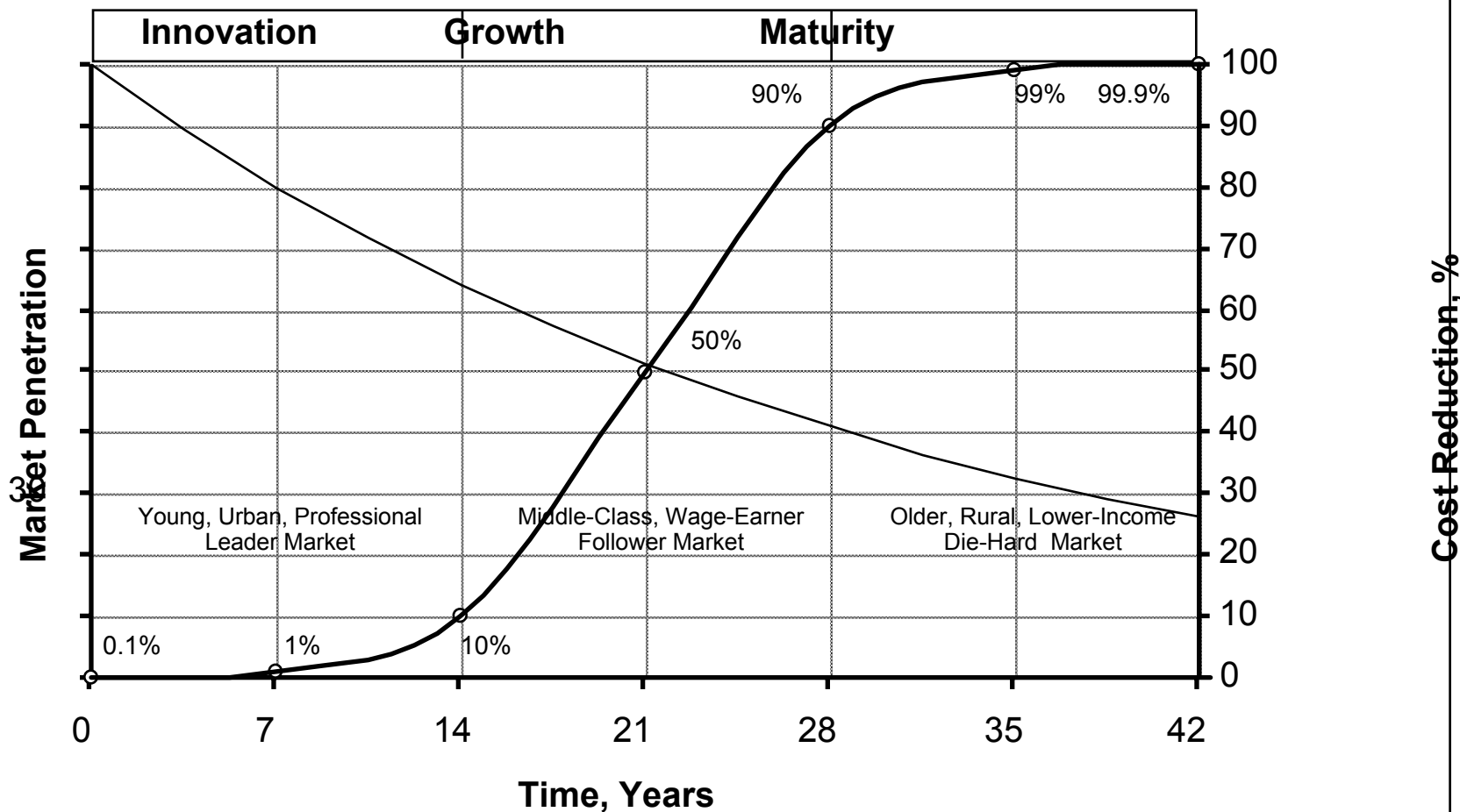
Innovation and Cost Life Cycles

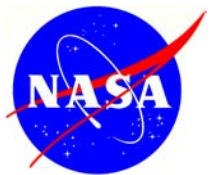
Small Aircraft Transportation System



(Trends follow classic “S-Curve” for innovations, Hugh B. Stewart, Recollecting the Future, 1988)

Cost & Market Penetration Life Cycles





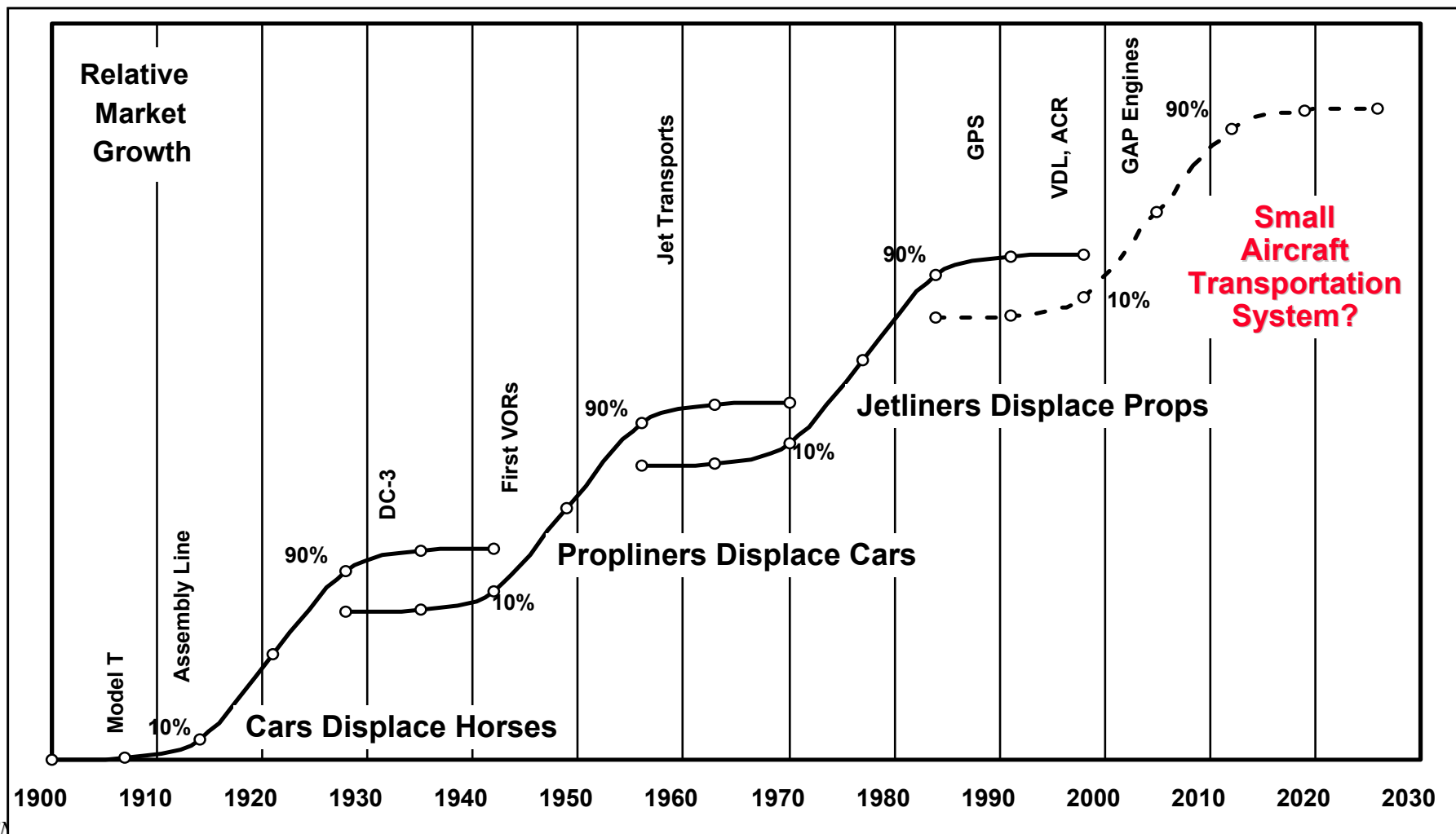
(R)evolutions in Higher Speed Travel

Small Aircraft Transportation System



What is Next? More Speed to More Destinations

The "Atomic Structure" of Business Innovation Cycles



Small airplane utility today...



...and the impact of mid-20th Century technologies...



...on the cost of 21st Century utility!!!



“Small airplanes

Small Aircraft Transportation System



...as the future for access, mobility and speed...



Isn't that a “disruptive” innovation?



And a couple of years later

Small Aircraft Transportation System



with continued demand for speed...

The same airplane, new engine!!!



to create (save) time!...

The future Generation of Cockpits, Propulsion, and Aircraft



Small Aircraft Transportation System



Lancair Columbia 300

FJX-2



Cirrus SR-20



Eclipse 500

QuickTime™ and a decompressor are needed to see this picture.



FJX-2

And others....



Toyota



Market Pull for Increased Mobility

Small Aircraft Transportation System



- **Booming Business Aircraft Market**
 - Dramatic growth in fractional ownership (50%/year)
- **New class of micro-jets / prop aircraft**
 - Low-cost: about \$1.50/aircraft-mile
 - Designed to access small airports
 - On-demand services emerging in market



And others....

What's Different This Time?

These are disruptive innovations, and...

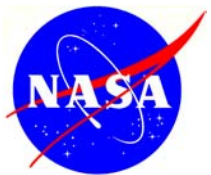
New aircraft

New entrepreneurs

New production system architectures

New customers





Underutilized Airports and Airspace

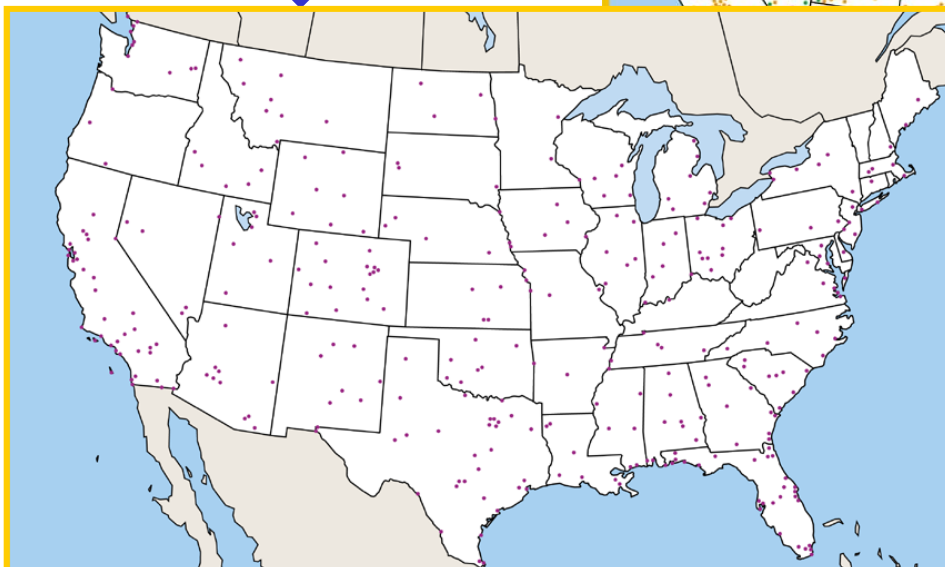
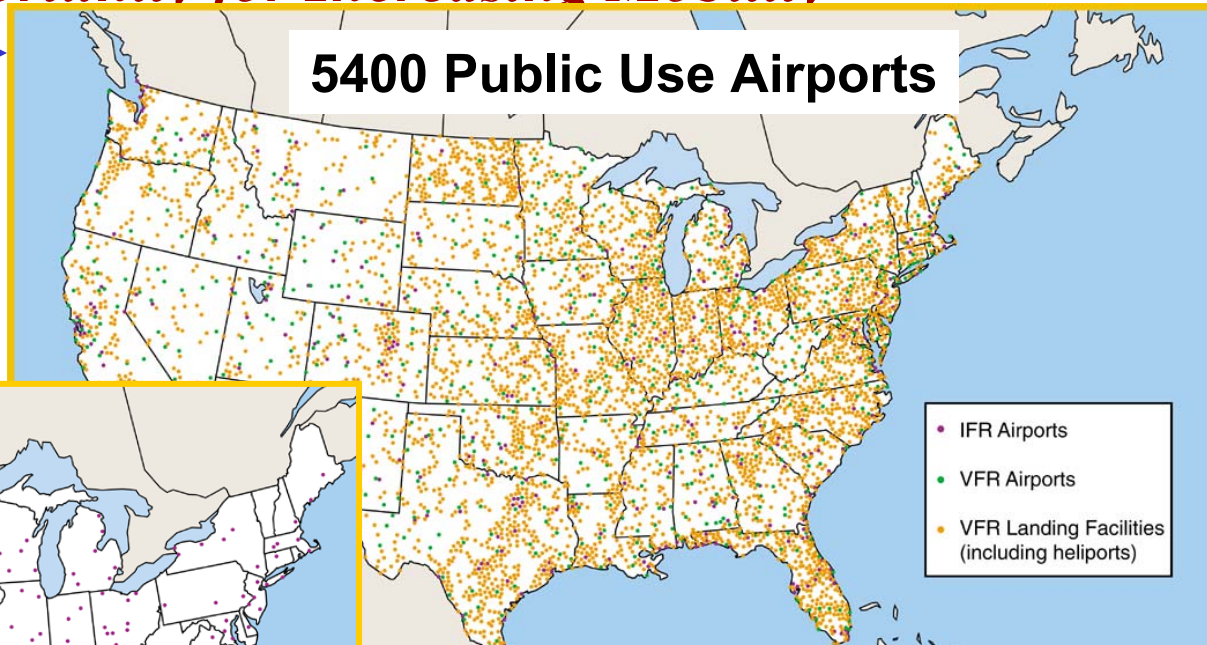
Small Aircraft Transportation System



... an Opportunity for Increasing Mobility

***Expanded Accessibility
to several times more
destinations***

5400 Public Use Airports



**Of 5,400 public-use airports, only 715 (13%)
have precision instrument approaches (ILS)**

**Near all-weather accessibility to
5,400 public-use airports?**

- **22% within 30 minutes of major/hub airport**
- **41% within 30 minutes of any commercial airport**
- **93% of population within 30 minutes of SATS-type airport**

Or 3222 NPIAS Airports?

Small Aircraft Transportation System



Small Aircraft Transportation System



- Program is a series of flight experiments leading to integrated flight demonstrations in FY2004-5 delivering:
- **Flight validation of enabling airborne technologies**
 - Revolutionary Integrated Flight Deck
 - Automated Flight path Management
 - Experimental Data Relevant to Certification
- **System Impact Analysis**
 - System cost/performance
 - Environmental/economic impact
- **Technology Infusion/Transfer**
 - Vested industry partners ready to implement
 - Accelerated technology commercialization



Resources:

\$69 million NASA
50/50 Cost Share
NASA/FAA/Industry Partnership
5 years, FY2001-2005
138 CS FTEs

SATS 5 Year Program Operating Capabilities

- Higher-Volume Operations in Non-Radar Airspace at Non-Towered Facilities:
Reliable Access to More Destinations through Efficient Use of Underutilized Airspace
- Lower Landing Minimums at Minimally-Equipped Landing Facilities:
More Landing Facilities Available More Often At Less Cost
- Increase Single-Pilot Crew Safety & Mission Reliability:
Safer Small Aircraft Operations, Greater Throughput in Underutilized Airspace
- Enroute Procedures & Systems for Integrated Fleet Operations:
Increased Mobility Without Sacrificing Capacity

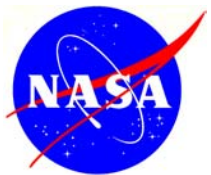


SATS Project Objectives

Small Aircraft Transportation System



- **Develop and evaluate technologies and operational concepts that enable the four operating capabilities**
- **Demonstrate the technical and operational feasibility of the four operating capabilities**
- **Assess SATS economic viability and impact on National airspace and airport infrastructure**
- **Demonstrate the value and potential impact of this technical and operational feasibility to the stakeholders, funders, and users**
- **Develop and operate the SATS Project in a public-private partnership to leverage resources and capabilities and to provide a vehicle to aid in technology infusion, commercialization, and certification**

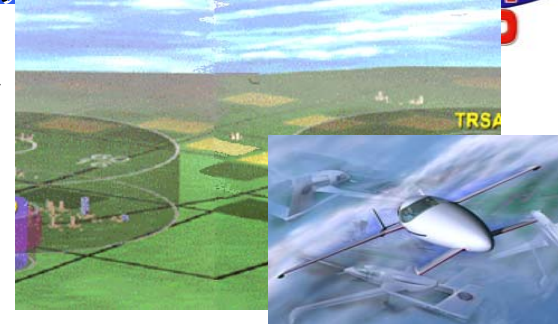


SATS Operating Capabilities

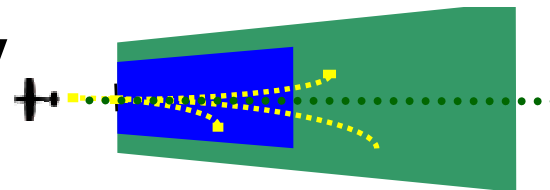
Small Aircraft Transportation System



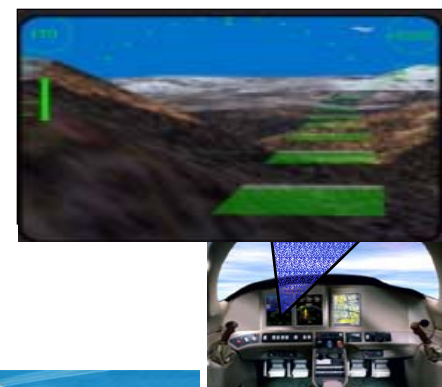
Higher Volume Operations in Non-Radar Airspace and at Non-Towered Airports



Lower Landing Minimums at Minimally Equipped Landing Facilities



Increase Single-Pilot Crew Safety & Mission Reliability

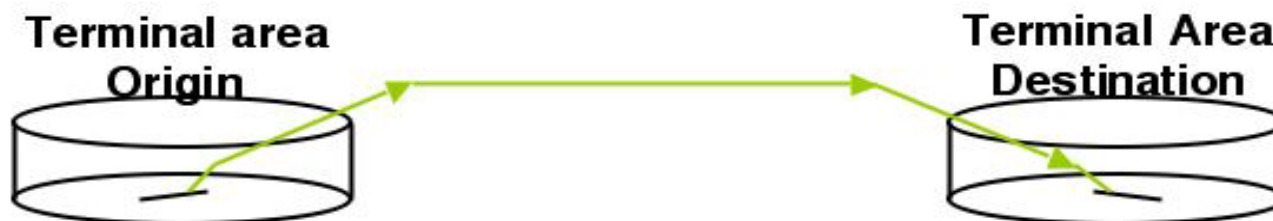


En Route Procedures & Systems for Integrated Fleet Operations





Initial Concept of Operations



Self Controlled Area (SCA)

- SCA surrounds airport
- Pilots must establish comm. with AMM prior to entering SCA
- Inside SCA, pilots responsible for separation from other traffic in IMC
 - Position exchange via ADS-B
 - Aircraft must have CDTI with Conflict Detection & Alerting
 - Each aircraft receives sequence info for other aircraft from AMM

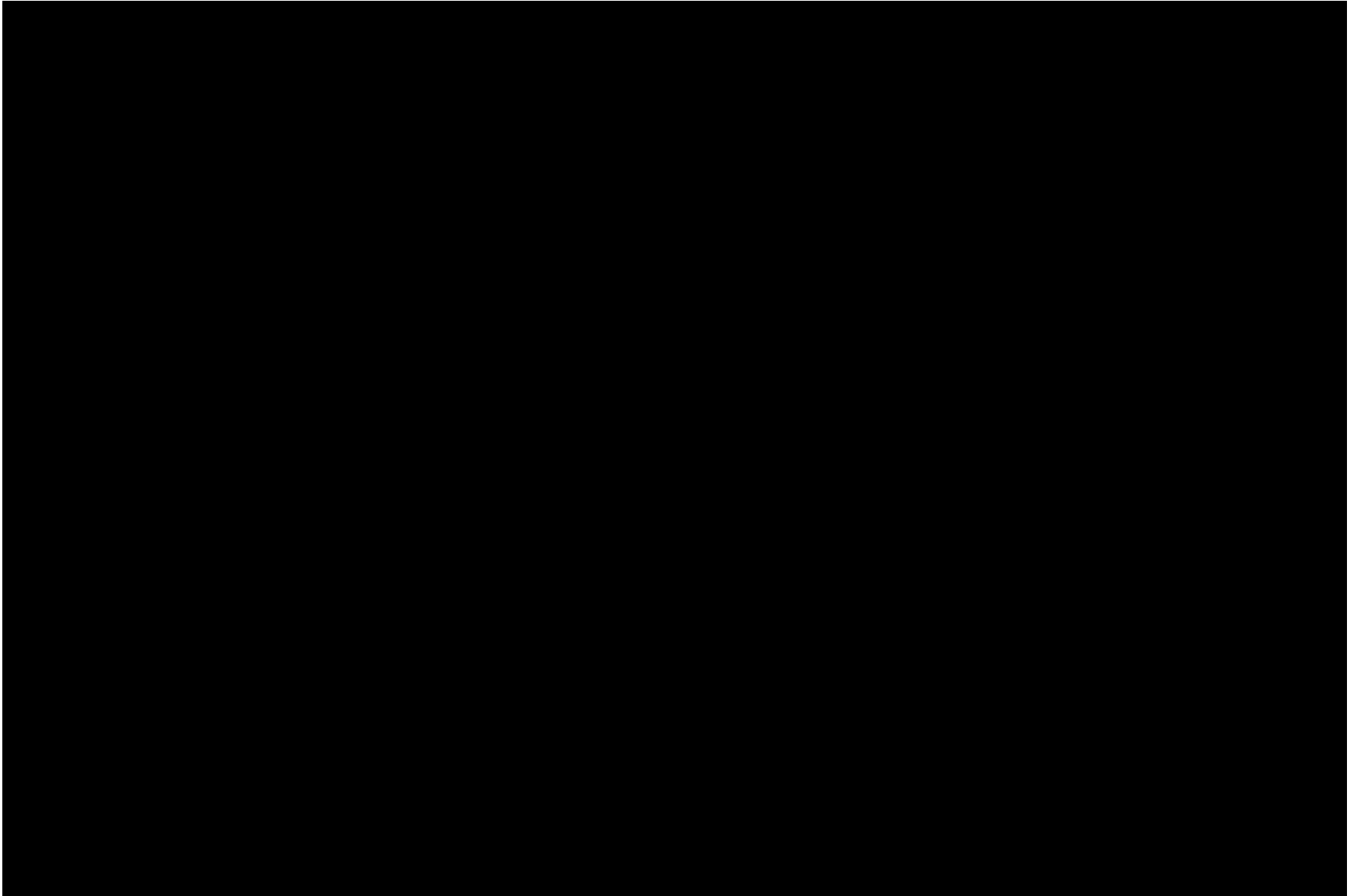
Airport Management Module (AMM)

- Located at airport
- Sequences aircraft
- Coordinates with ATC
- Provides airport info (e.g., ATIS, procedures)

Rules of the Road

- Safe resolution of traffic conflicts without impeding traffic flow
- Immediately departing/arriving aircraft have highest priority
- Aircraft with lower arrival sequence numbers have priority over those with higher sequence

SATS Operating Capabilities Animated



Airborne Internet....SATS and Beyond



Small Aircraft Transportation System



Mobile connectivity is a growing technology in our society today. Its growth is fueled by the desire of **people wanting to remain connected to "the network" even while traveling.** From wireless LANs at home and the office to **wireless connectivity with Personal Digital Assistants (PDAs),** people are utilizing new methods to **extend the traditional network connectivity that originated with a wire** to a computer.

The idea of using these same **mobile connectivity** has found its way **into aviation...**and is being applied to comm, nav. & surveillance functions.

The concept of basic **network connectivity** could be used to **connect other mobile vehicles, including automobiles, trucks, and trains.** Network connectivity could be obtained **between vehicles and a ground network** infrastructure, thus enhancing their ability to process data relative to their operation.

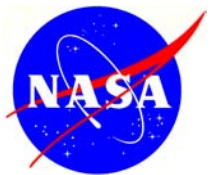
The Small Aircraft Transportation System is a safe travel alternative, freeing people and products from transportation system delays, by creating access to more communities in less time.

Airborne Internet is an idea from NASA's Small Aircraft Transportation System (SATS) program planning.

Imagine a robust communications channel, aircraft to aircraft and to ground networks.

Airborne Internet potential extends beyond SATS....enabling new operating capabilities, safety, and efficiency for tomorrow's transportation systems.

The Genesis of an idea.....Airborne Internet

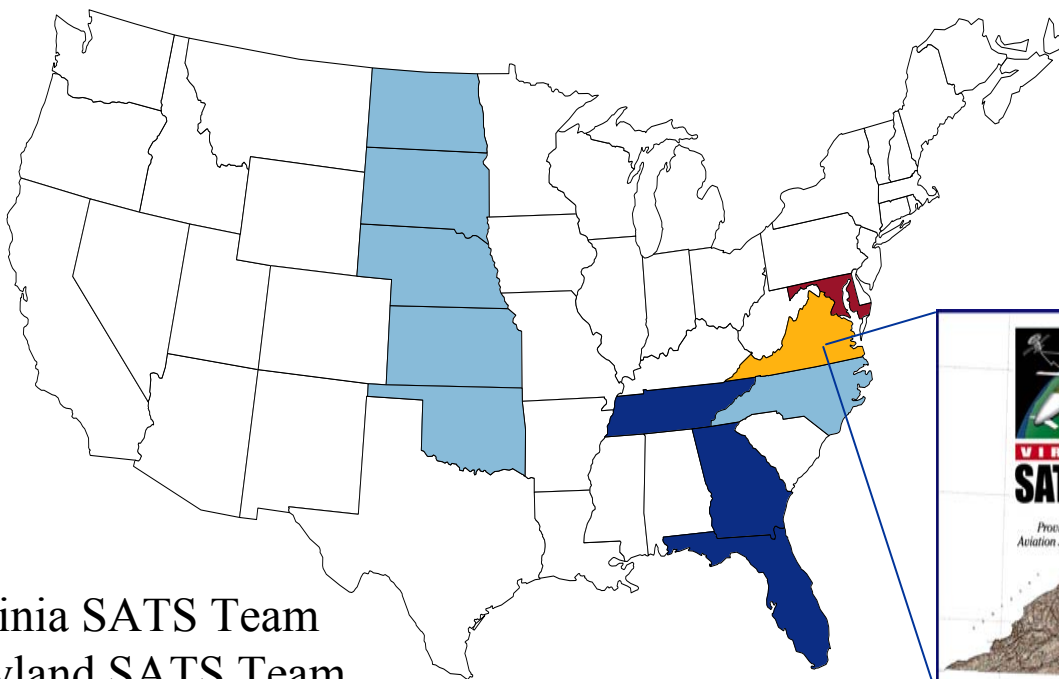


SATSLabs and A.I.

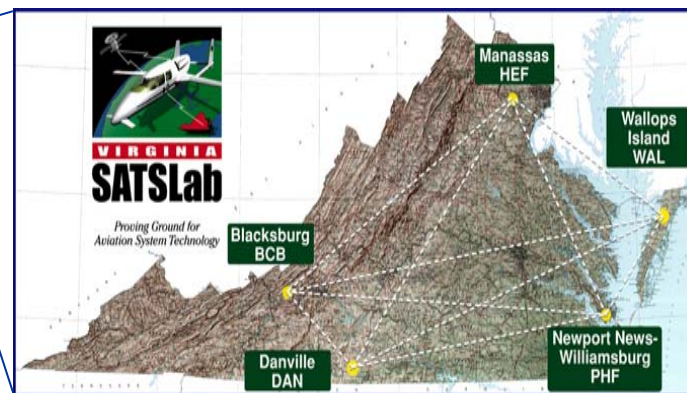
Small Aircraft Transportation System



- ***Each SATSLab has some level of interest in A.I.***
- ***The level of interest in A.I. Varies between the Labs***



- Virginia SATS Team
- Maryland SATS Team
- Southeast SATS Team
- North Carolina & Upper Great Plains SATS Team.





A Surveillance Radar Example

Small Aircraft Transportation System

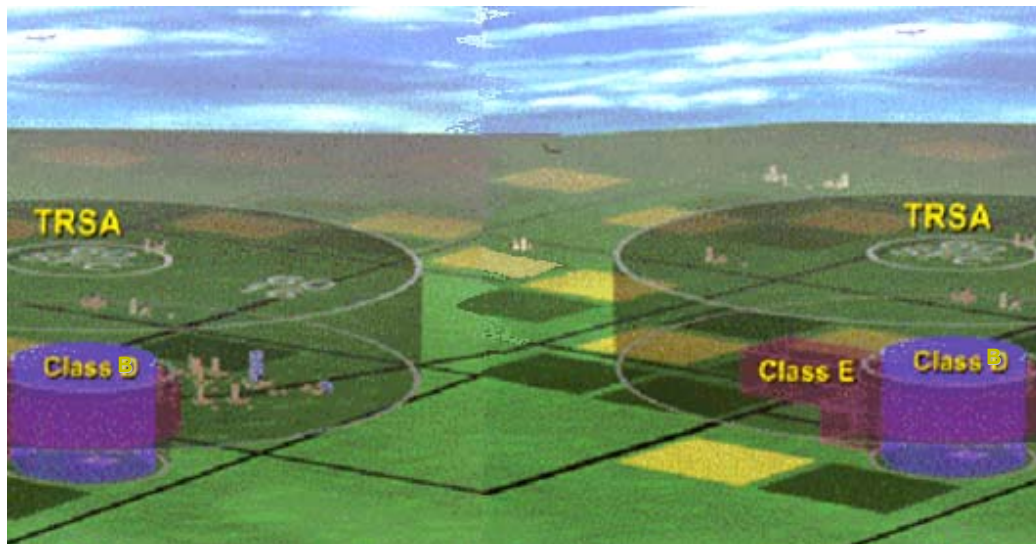


A/C tracking depends on secondary surveillance radar

Transponders in A/C reply to ground interrogations from surveillance radars. ATC has positive knowledge of A/C position, altitude, etc.

**Outside of radar coverage
ATC has no positive
knowledge of A/C position,
altitude, etc.**

- Use checkpoint reporting



Current System:

Technology:

Goal

Limitations:

Radar dependant airspace. Radars are installed as airspace traffic density increases (e.g. NE U.S.)

- Analog technology foundation
- Dual function transponder
- Line of sight

- Provide aircraft altitude, range, ID code
- Extensive processing can provide flight trend prediction

- Flight coverage is geographic dependant
- Low altitude gaps
- Many GA airports not covered

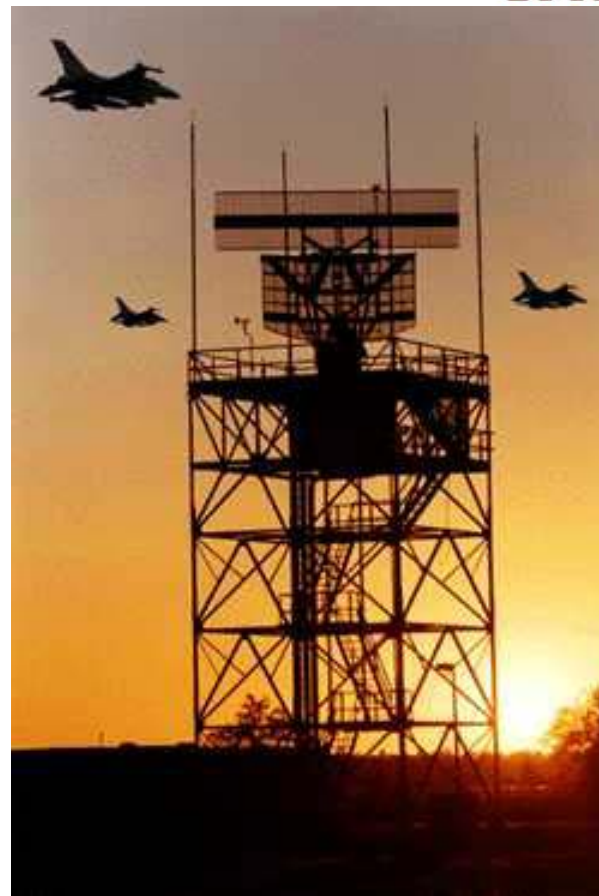


Surveillance Radar

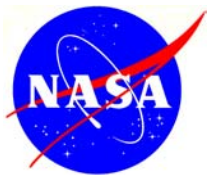
Small Aircraft Transportation System



- Being modernized to add digital capability
- Conversion of basic analog technology foundation
- NOT a new concept, pre-GPS
- Will still have limited coverage area
- A/C require transponders based on technology that is decades old
- NAS has about 400 surveillance radars
- May require Multilateration to add accuracy



When has a technology passed its prime?



A History of SS Radar Technology

Small Aircraft Transportation System

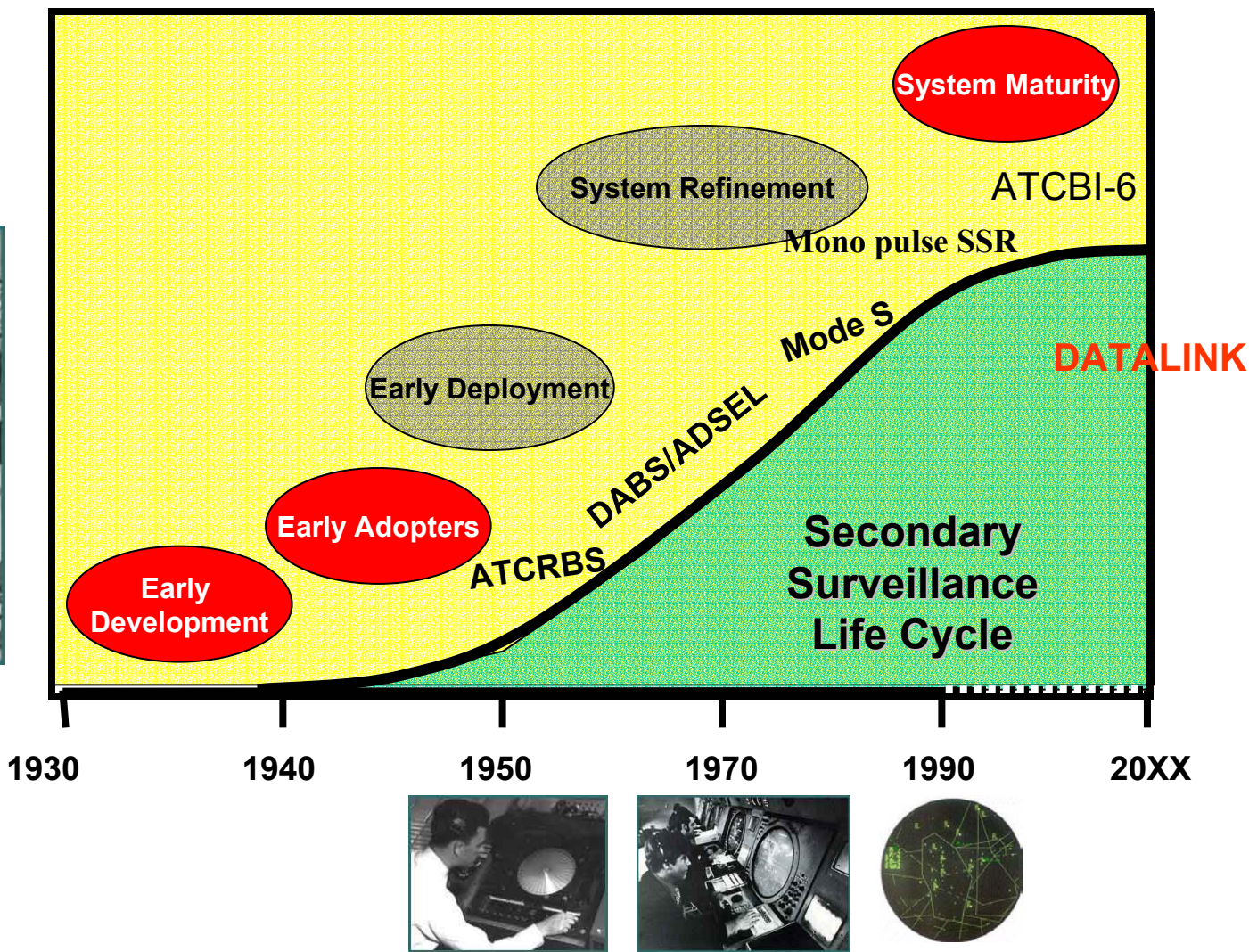


British Develop
radar for air defense
(preWWII)

CAA deploys ASR-1
FY 1950



First ASR antenna
at Smithsonian



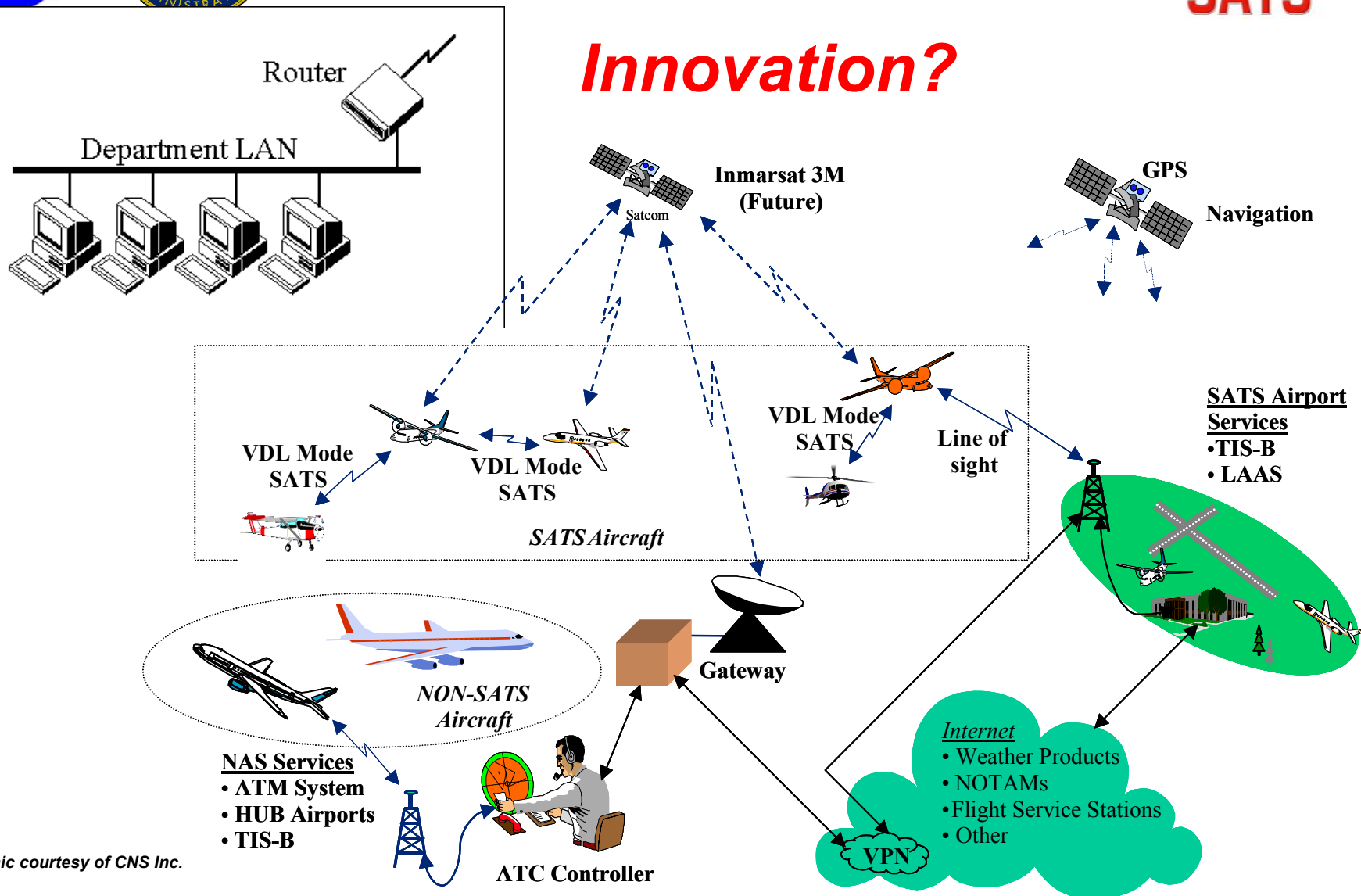


Network Aircraft as we do Computers

Small Aircraft Transportation System



Innovation?



Graphic courtesy of CNS Inc.

KEY REQUIREMENTS:

Reliable Connection to Network

Where Current aviation voice comm is VHF...

- Retain voice but add/emphasize data and voice over IP
- Continue to use VHF but add Satellite
- Use ***BOTH*** to maintain mobile connectivity while optimizing user selected characteristics (speed of communication, message cost, safety of flight, etc)
 - + Provides equipment and frequency diversity
 - + Spectrum efficient
- Report GPS/WAAS position data continually to network

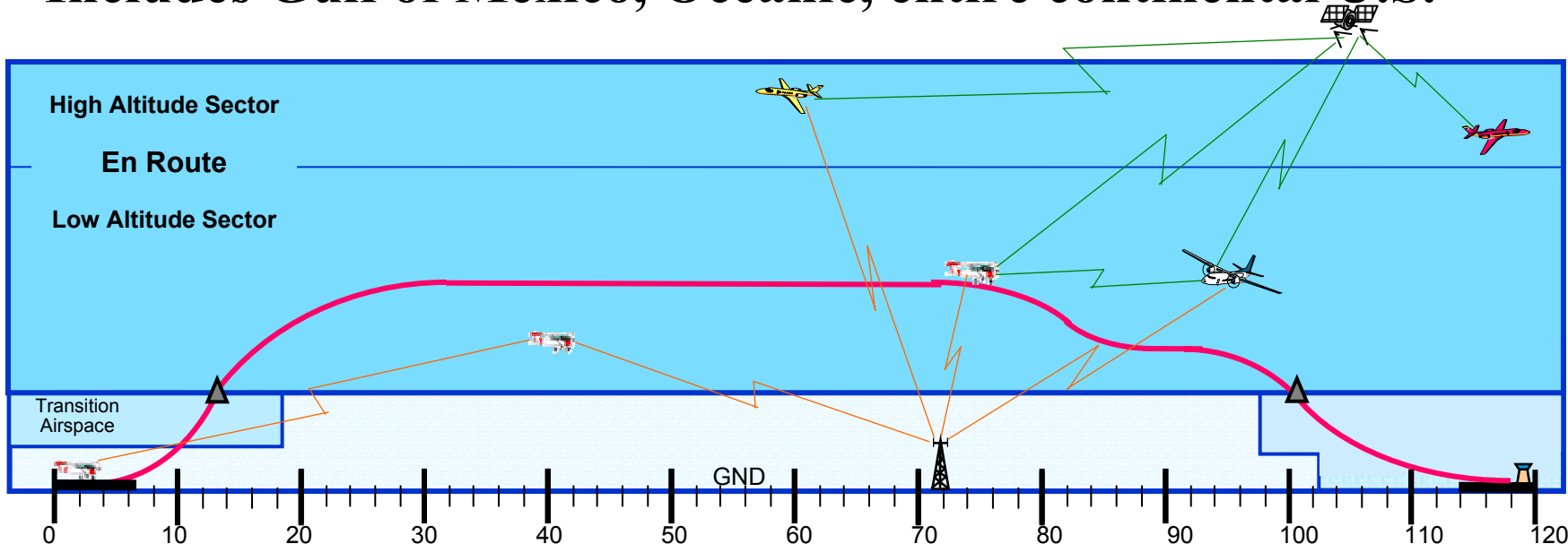


Flight Tracking at All Altitudes

Small Aircraft Transportation System



- ATC participation for ALL aircraft
- Coverage: Ground up
- Includes Gulf of Mexico, Oceanic, entire continental U.S.



Graphic courtesy of CNS Inc.



Airborne Internet Accomplishments

Small Aircraft Transportation System



- **Task 1**: Conducted technology assessment, NAS Infrastructure assessment, built first AI Demo set for proof of concept. (completed Jan 2002)
- **Task 2**: Produced interface description document, conduct AI demos, add NOTAMs capability. (May-Sept 2002)
- **Task 3**: Upgrade NASA LARC D.I.F. trailer to AI DARTS capability, add a/c system, Network Application Service Interface Document, Functional Description Document, tech notes on interface to Harris ADS-B mapping system.

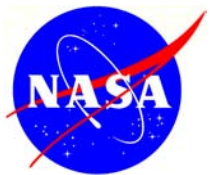
Digital Applications Research & Test System



Small Aircraft Transportation System

(DARTS)





Potential Benefits

Small Aircraft Transportation System



- ***Data transfer and applications available to commercial and GA***
- ***Spectrum efficient: many functions over a single/dual frequency***
- ***Minimizes the number of radios and antennas on an aircraft***
- ***Voice over IP***
- ***Provide ATC coverage to aircraft in non-radar environments***
 - ***Limited or no ground equipment required at airport***
- ***Surveillance augmentation includes Gulf of Mexico and Oceanic***
- ***ATC Flight following to more GA aircraft***



Why Consortium?

Small Aircraft Transportation System



- **Leverage resources.**
- **Join common interests for greater impact**
- **Establish a legal entity for funding and information sharing during development**
- **Collaborate to produce guidelines and standards that will provide a roadmap to FAA certification (GS&Cs)**
- **Individual participants/contributors will enjoy early market deployment opportunities.**

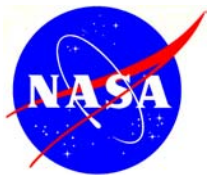


Consortium Membership

Small Aircraft Transportation System

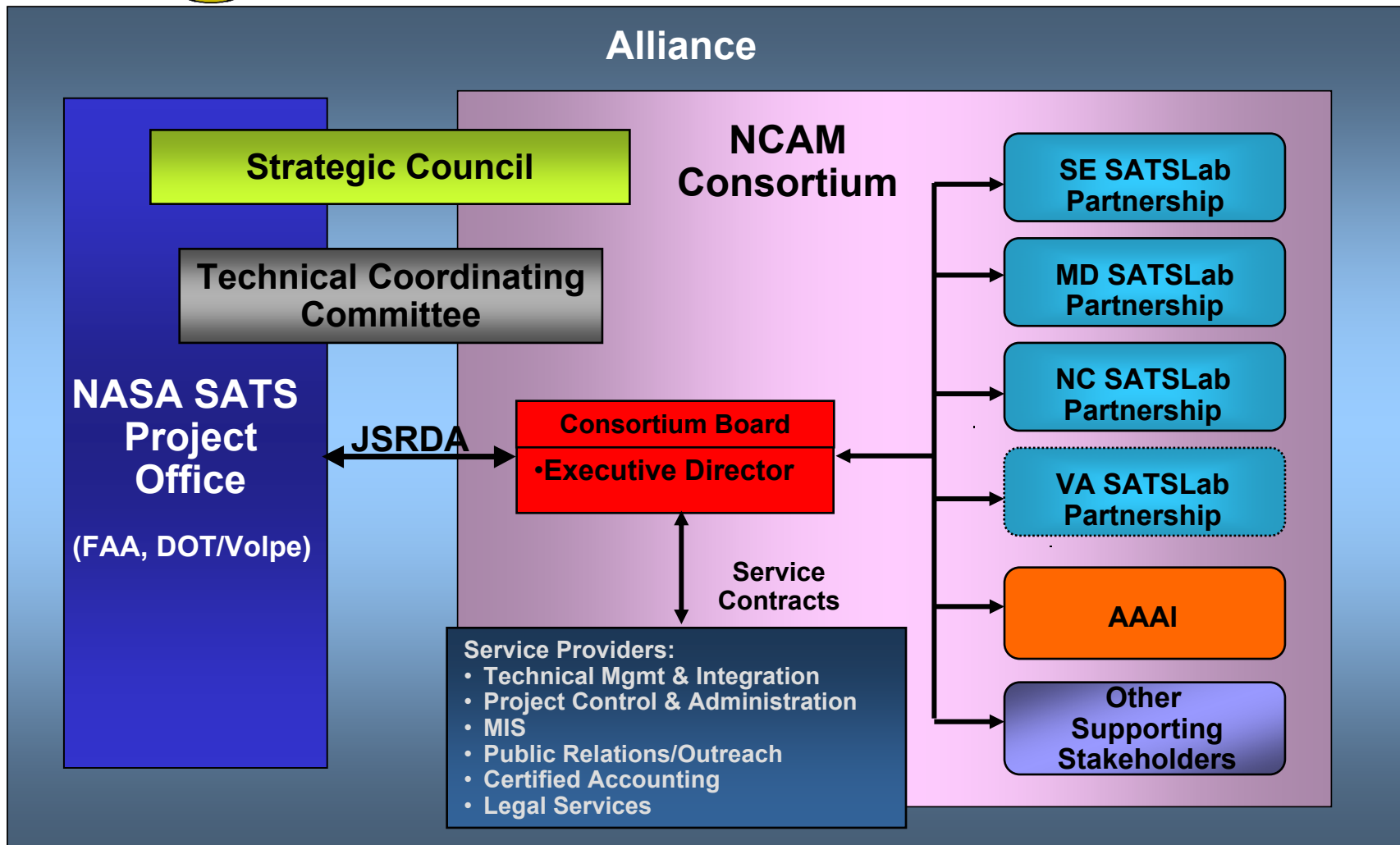


NATIONAL CONSORTIUM FOR AVIATION MOBILITY (NCAM)



SATS Alliance Structure

Small Aircraft Transportation System





How you might want to view SATS?

Small Aircraft Transportation System



SATS began as a vision...2010 and 2020/25

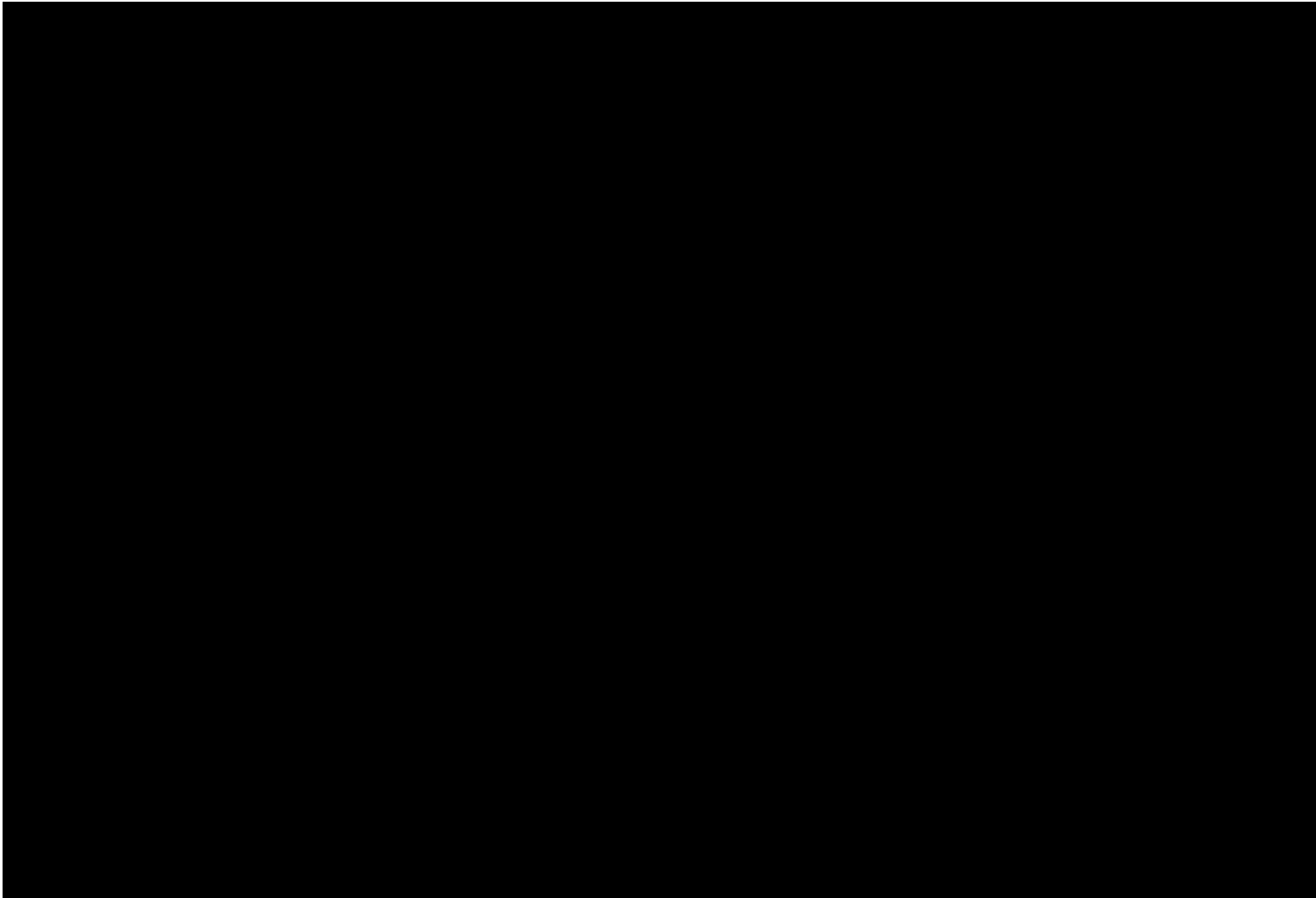
SATS springs from national transportation and economic needs and National Airspace System gap analyses.

SATS seeks to exploit existing, perhaps underutilized, NAS resources, and emerging as well as new technologies.

SATS, the name, is un-important. The technologies and operating capabilities being considered/introduced are important.

SATS is not the “solution” for all NAS challenges, merely one alternative, based on enabling technology, for consideration.

The SATS *public private partnership* model is a key discovery and project deliverable.





For more information:

Small Aircraft Transportation System



Ralph Yost

Innovations Division, ACB-100

William J Hughes Technical Center

Atlantic City Airport, NJ 08405

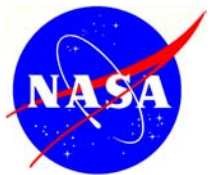
(609) 485-5637

Ralph.Yost@faa.gov

http://acb100.tc.faa.gov

http://www.AirborneInternet.com

http://www.airborneinternet.net



Is this “vision” enough?

Small Aircraft Transportation System



“Vision” can be a powerful aiming point for research and new business opportunity!



We can not permit our vision of transportation’s future to merely be a more efficient past!

FAA’s Pete McHugh...

...loudly and often!!!

Why set ambitious transportation goals!?



Small Aircraft Transportation System



For me, this little guy (and his sister) are reason enough!

**From Wheels
to Wings on America**

**Future
Transportation
safety, efficiency, speed**

**Equitable
On-Demand
Widely Distributed
Point-to-Any Point
21st Century Air Mobility**

